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Cognitive Function in the Community Setting: The Neighborhood as a Source of "Cognitive Reserve"?

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Abstract

Background—Existing research has found a positive association between cognitive function and residence in a socioeconomically advantaged neighborhood. Yet, the mechanisms underlying this relationship have not been empirically investigated. This study tests the hypothesis that neighborhood socioeconomic structure is related to cognitive function partly through the availability of neighborhood physical and social resources (e.g. recreational facilities, community centers and libraries), which promote cognitively beneficial activities such as exercise and social integration.

Methods—Using data from a representative survey of community-dwelling adults in the City of Chicago (N = 949 adults age 50 and over) we assessed cognitive function with a modified version of the Telephone Interview for Cognitive Status (TICS) instrument. Neighborhood socioeconomic structure was derived from US Census indicators. Systematic Social Observation was used to directly document the presence of neighborhood resources on the blocks surrounding each respondent's residence.

Results—Using multilevel linear regression, residence in an affluent neighborhood had a net positive effect on cognitive function after adjusting for individual risk factors. For white respondents, the effects of neighborhood affluence operated in part through a greater density of institutional resources (e.g. community centers) that promote cognitively beneficial activities such as physical activity. Stable residence in an elderly neighborhood was associated with higher

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COMPETING INTEREST
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cognitive function (potentially due to greater opportunities for social interaction with peers), but long term exposure to such neighborhoods was negatively related to cognition.

Conclusions—Neighborhood resources have the potential to promote "cognitive reserve" for adults who are aging in place in an urban setting.

Keywords

cognitive function; neighborhood; urban health; elderly

INTRODUCTION

Dementia is a common and disabling brain disorder among older adults that has consequences for independence, functional decline, institutionalization, and mortality (1–3). The key feature of dementia is a decline in cognitive function, including impairments in memory, attention, and executive function. There is growing evidence that risk factors at both the individual and community levels are related to cognitive function.

At the individual level, evidence has been accumulating that hypertension, obesity, diabetes and heart disease are risk factors for cognitive impairment and dementia, in part through pathways such as chronic inflammation and oxidative stress (4). Conversely, physical activity (particularly frequent or vigorous physical activity) and adherence to a Mediterranean-type diet have been found to be protective against cognitive decline (5–9), likely a result of decreased vascular inflammation. At the same time, social interaction and integration within a social network are associated with a lower incidence of dementia (10–12), potentially due to greater opportunities to engage in healthy behaviors or the increased mental stimulation afforded by integration within a supportive social network. Similarly, individuals with more formal years of education have a reduced risk of dementia (13, 14), at least partly as a result of similar underlying pathways. Collectively, these findings have contributed to the "cognitive reserve" hypothesis (15), which suggests a direct effect of mental stimulation or physical activity on brain development and function that mitigates cognitive decline either through neural reserve (pre-existing brain networks have more capacity and are therefore less susceptible to decline) or neural compensation (capacity to activate alternate networks to compensate for pathological disruption).

Recently, a parallel literature has begun to examine the relationship between cognitive function and characteristics of the surrounding environment using secondary data sources (e.g. decennial Census) linked to individual survey respondents. This research has shown that, controlling for individual socioeconomic resources, living in an area with a high proportion of adults with low levels of education is associated with lower cognitive function among American older adults (16). This effect was particularly pronounced for older adults with the least education (16), highlighting the importance of incorporating cross-level interactions to consider questions of "person-environment fit" for potentially vulnerable sub-populations (17). Similar findings have been found in the United Kingdom, where neighborhood socioeconomic deprivation (e.g. high proportion of low income, unemployed, and lower educated residents) was associated with decreased cognitive function (although no cross-level interactions were found) (18). Using longitudinal data for older Mexican Americans, Sheffield and Peek (19) found that, net of individual socioeconomic status, residence in an economically advantaged area (e.g. high household income) was associated with slower rates of cognitive decline over a five year period.

Authors of these papers have speculated that living in highly educated and socioeconomically advantaged neighborhoods may promote cognitive function and/or buffer cognitive decline in part through their greater density of physical resources (recreational

centers, gyms, parks, walking paths, healthy food stores) as well as social and institutional resources (libraries, bookstores, community centers, social clubs) (16, 19) that promote protective health behaviors (e.g. physical activity) and facilitate mental stimulation (e.g. social interaction and cognitive activities such as reading and/or playing games). However, to date these hypothetical pathways have not been empirically tested.

In this paper we explicitly test the hypothesis that neighborhood socioeconomic structure is associated with the prevalence of neighborhood physical and social resources, which in turn are associated with the frequency of physical and social activities of individuals in these environments, and resulting levels of cognitive function (Figure 1). Following the existing literature (16) we also test for cross-level interactions between neighborhood context and individual socioeconomic and sociodemographic position, hypothesizing that contextual composition or resources may be particularly salient for individuals at highest risk for cognitive impairment (e.g. older adults, racial/ethnic minorities, or those from lower socioeconomic position). Contextual effects may also vary by duration of exposure to particular neighborhoods, as reflected by cross-level interactions with residential tenure.

We test these hypotheses using a large representative survey of Chicago residents 50 years of age and older with a rich array of data on neighborhood characteristics. Consistent with the existing literature we focus on indicators of neighborhood socioeconomic disadvantage (typically captured through the proportion of residents in poverty, on public assistance, and unemployed) and examine its impact on cognition through the shortage of physical (e.g. recreational centers, parks) and institutional (e.g. libraries, churches, schools) resources in each neighborhood, as well as through indicators of neighborhood social and physical disorder (e.g. visual signs of decay, crime). We also examine the effects of neighborhood age structure, speculating that cognitive function is better when living in an area with a higher proportion of older adults, in part through increased opportunities for social interaction with peers or a greater density of age-specific resources (e.g. senior centers). We also go beyond examining the effect of disadvantaged neighborhoods to consider the effects of affluent neighborhoods (20, 21), which are distinguished by the demographic profile associated with gentrification (e.g. highly educated, young adults, working in professional occupations), and likely to attract a set of institutions and resources conducive to cognitive health (e.g. places to exercise, well maintained buildings and parks). Consistent with the existing literature we focus on two mediators of these environments among individuals, levels of physical activity and social integration, and we control for a broad array of individual socioeconomic and sociodemographic characteristics that could confound the relationships under study.

METHODS

Data

Data come from the Chicago Community Adult Health Study conducted in 2002 through face-to-face interviews with a multi-stage representative sample of 3,105 adults aged 18 and over, living in all 343 neighborhood clusters in the city of Chicago (22). A response rate of 72% is one of the highest in a major American city in recent decades (23). The weighted sample matches the 2000 Census population estimates for the city of Chicago in terms of age, race/ethnicity and gender. To focus on the age group most at risk for the development of cognitive impairment (2), we restrict our analyses to 949 adults age 50 and over. All study procedures were reviewed and approved by the University of Michigan's Institutional Review Board and study participants gave informed consent.

Outcome Measure

Cognitive function was assessed using a modified version of the Telephone Instrument for Cognitive Status (TICS) (24). A composite index was derived from five tasks assessing memory, orientation, and executive functioning: (a) an immediate word recall test of 10 common nouns (10 points); (b) a delayed recall test of the same 10 nouns approximately 5 minutes later (10 points); (c) naming the day of the week and the date (2 points); (d) naming the current president of the United States and the past president (2 points); and (e) a serial 3's test that required subtracting 3 from 20 six times (1 point). A summary score was created by summing the number of correct answers (max=25), with a higher score indicating better cognitive function. Refusals to answer any question were coded as incorrect.

Neighborhood Measures

We include indicators from the US Census using the census tract as a proxy for neighborhood. Census tracts have on average about 4,000 people and are designed to capture homogenous areas that roughly map to neighborhoods (25). Each respondent's address was geocoded to the 2000 census tract, and linked to the US Decennial Census for that year. We focus on three indices of neighborhood social and economic structure. The ***age structure*** of a tract is captured through the proportion of persons in each tract who are age 65 and older. ***Neighborhood socioeconomic disadvantage*** is an average of six census indicators: percent households with income less than $15,000 annually, percent households with incomes over $50,000 annually (reverse coded), percent of working age adults who are unemployed, percent families in poverty, percent households on public assistance income, and percent female-headed families. ***Neighborhood affluence*** is an average of four census indicators: percent adults with college degrees or higher, percent adults in professional or managerial occupations, percent adults age 30 to 39 years, and median home value (expressed as a percentage of the maximum median home value in all sampled census tracts). Factor loadings for the items in the socioeconomic indices range from .82 to .95 (disadvantage) and from .71 to .99 (affluence); corresponding alpha reliabilities = .95 and .90, respectively.

Neighborhood Resources

In addition to census indicators we draw on a rich source of data on neighborhood resources. The Chicago Community Adult Health Study was specifically designed to examine the relationship between neighborhoods and health, and observational data were collected on the city block around each respondent's residence through the method of systematic social observation (SSO) (26, 27). SSO capitalizes on the interviewer's visit to the home to directly measure the physical and social conditions of the block during the day. While walking around the residential block where each respondent lives, the survey interviewer characterized these respondent-centered neighborhoods using a standardized instrument. Inter-rater reliability of this method was demonstrated using a subsample of 80 blocks in a pilot study conducted in 2001 where two raters made separate, independent observations of the same block at the same time (agreement = .78 to 1.00; κ =.27 to .91).

We constructed tract-level measures of neighborhood resources from these block level observations, including the proportion of blocks within the tract where there are public ***recreational centers*** (e.g. gyms, swimming pools, or buildings where residents can exercise and play sports) as well as ***institutions*** such as schools, churches, libraries, and community centers that provide opportunities for social interaction or intellectual stimulation. An index of ***neighborhood disorder*** (27) (capturing social and physical disorder that may discourage residents from accessing resources in their neighborhood) is derived from observations of the block with respect to the presence of graffiti, garbage, litter or broken glass, cigarette butts, empty beer/liquor bottles, abandoned cars, and drug-related paraphernalia or condoms on sidewalks or in street gutters, that are aggregated to the tract level using multilevel item

response models to create an overall measure expressed on a logit scale (ranging from negative to positive), with a high score indicating a high presence of disorder (alpha reliability =.935). In addition, we draw on geographic data from the City of Chicago to create a measure of ***park area*** in square miles in each census tract. We include indicators for each respondent's length of residence at current address in order to capture duration of exposure to these environments.

Individual Mediators

We focus on two potential mediators of neighborhood resources at the individual level. First, ***social integration*** is assessed by the frequency of getting together with friends, neighbors and relatives, either going out together or visiting in each others' homes (measured on a six point scale ranging from 0 to 5 (never, less than once per month, once per month, 2 or 3 times per month, once a week, more than once a week)). Respondents were also asked to indicate whether they participated in community or civic activities within the past year (e.g. worked on a community project, attended a community meeting). A binary variable for ***civic engagement*** indicates whether the respondent participated in any such activity in the past year.

Second, respondents were also asked to report on their ***physical activity*** habits in a typical week over the past 12 months. Using questions from the National Health Interview Survey (28) respondents were asked about "physical activities such as exercise, sports, or physically active hobbies that you do in your leisure time and that cause you to sweat or increase your breathing or heart rate". Activities were classified as either light to moderate (light or moderate activities for at least 10 minutes that cause only light sweating or a slight to moderate increase in breathing or heart rate; walking continuously for 20 minutes or more; home maintenance such as painting or outside yard work, including gardening and shoveling snow) or vigorous (engaging in activities for at least 10 minutes that cause heavy sweating or large increases in breathing or heart rate). Following Scarmeas et al., (8) a three category summary physical activity variable was constructed based on the frequency and intensity of activities: *no physical activity* (no walking, exercise, sports or physically active hobbies); *some physical activity* (light to moderate physical activity once a week or less regardless of duration, light to moderate activity 2–3 times per week for 20 minutes or more, light to moderate activity 4 or more times per week for less than 20 minutes, vigorous activity once per week or less for 20 minutes or more, walking once a week or less for 20 or more minutes, or working around the house 1–3 times per week); and *heavy physical activity* (light to moderate activity 4 or more times per week for 20 minutes or more, vigorous activity 2 or more times per week regardless of duration, walking 20 minutes or more 2 or more times per week, or working around the house 4 or more times per week).

Individual Controls

We control for key sociodemograhpic and health factors that could account for the relationships between cognitive function and neighborhood characteristics. ***Sociodemographic factors*** include age, gender, marital status, race/ethnicity, employment status, and socioeconomic position (SEP). *Age* is represented by two dummy variables contrasting young-old (age 60 to 69) and very old adults (age 70 plus) with middle-age adults (age 50 to 59). *Gender* is a dummy variable coded 1 for males and 0 for females. *Marital status* is captured by three dummy variables contrasting divorced/ separated, widowed, and never married, with married respondents. *Race/ethnicity* is categorized according to three dummy variables contrasting Black, Hispanic, and other race/ethnicity (including Native American, Asian, or Pacific Islander) with Whites. *Employment status* is captured using three dummy variables contrasting the unemployed, retired (or unable to work because of a health problem), and homemakers, with employed respondents.

S*ocioeconomic position* is assessed through the respondent's level of education (classified as less than high school, high school diploma, or college degree) and reported household income (captured with two dummy variables contrasting those with annual incomes less than $15,000 and $15–40,000 with those whose annual incomes are over $40,000; a dummy variable indicates missing data on income). We also control for underlying physical ***health status*** using an index of self-reported *chronic health problems* that sums the number of medically diagnosed health conditions (e.g. hypertension, heart attack, stroke, arthritis, diabetes, peripheral artery disease). (Additional controls for smoking, body mass index, depressive symptoms, living arrangements, and immigrant status were also considered (results not shown), but did not change the results reported here.)

Statistical Analyses

To account for the clustering of observations within census tracts (mean=2.1 respondents per tract, range=1–11) (29) we used multilevel linear regression to examine the effect of neighborhood characteristics on cognitive function. Analyses were performed with the MIXED procedure in SAS Version 9.2 and the neighborhood variables were grand mean centered with a standard deviation of one (30). Statistical significance was assessed with a two-tailed alpha of .05 and all models were weighted by post-stratification sample weights to account for the sampling design as well as differential coverage and non-response across neighbourhood clusters.

RESULTS

Descriptive statistics for the study sample are presented in Table 1. Average scores on the cognitive function measure fall at the mid-point of the scale (range 2–24) and the overall distribution of the scores follows a normal distribution. Respondents visit with friends and neighbors about once a week on average, and about half have participated in a community activity in the past year. Two-thirds engage in some physical activity in typical week, while 12 percent are not physically active. Respondents tend to be long term residents of their neighborhoods, with over half residing at their address for ten years or more.

Table 2 presents the results from the multilevel linear regression models. The first column (Model A) reports the results for the unconditional (intercept only) model. There is significant variation in cognitive function across census tract neighborhoods (variance components for the intercept, $p<.001$), with almost 30 percent of the total variation in cognitive function lying between tracts (intraclass correlation coefficient (ICC) =.29). The second column (Model B) in Table 2 adds the neighborhood census indicators and, as hypothesized, neighborhood socioeconomic disadvantage is associated with worse cognitive function while neighborhood affluence is associated with better cognitive function (a one standard deviation increase in neighborhood affluence is associated with almost a one point increase on the cognitive function measure).

The third column of Table 2 (Model C) adds the individual control variables that could account for the relationship between neighborhood census characteristics and cognitive function if, for example, individuals with more risk factors for lower cognitive function (e.g. health problems, lower education) tend to live in areas characterized by neighborhood socioeconomic disadvantage. Indeed, the negative effect of living in a disadvantaged neighborhood is completely explained by the addition of the control variables, but a net positive effect of neighborhood affluence on cognition remains. The effects of neighborhood age structure become statistically significant after adjusting for the controls, but the effects vary by duration of residence in the neighborhood as indicated by significant cross-level interactions with residential tenure. As hypothesized, residence in an area with a higher proportion of older adults was positively associated with cognitive function, but only for

those with more stable exposures to these neighborhoods (tenure of 6 to 10 years), and was negatively associated with cognition for very long term residents of these types of neighborhoods (more than 10 years). (Other cross-level interactions involving sociodemographic or socioeconomic variables were not statistically significant.) Results from Model C also illustrate notable gender, racial/ethnic, and socioeconomic disparities in cognition. Males, non-whites, and those with less than a college education have significantly lower cognitive function scores, net of the effects of income and health status. Widowhood, retirement, and being a homemaker are also associated with worse cognitive function.

Model D in Table 2 adds the neighborhood resources that were hypothesized to explain the effect of neighborhood socioeconomic structure on cognition. We found no effect of the proportion of recreational centers or park area in one's neighborhood, but living in a neighborhood with a higher density of institutional resources (such as libraries, schools, and community centers) was associated with higher cognitive function scores, net of individual resources. However, this benefit was reserved only for white respondents. Exposure to greater institutional resources was negatively associated with cognitive function for African Americans (and negatively but not significant for Hispanic adults). Institutional resources account for almost half of the adjusted effect of neighborhood affluence on cognition ((.28-.15)/.28=.46, Model C to Model D), effectively explaining the statistical significance of the positive affluence effect. Neighborhood resources did not explain any of the effects of neighborhood age structure on cognitive function.

Models E and F in Table 2 add the physical activity and social integration variables to try to explain the adjusted effects of neighborhood resources on cognitive function. Vigorous physical activity (Model E) was positively associated with cognition, explaining a small part (4%) of the positive effect of institutional resources for white respondents ((1.81–1.73)/1.81=.04, Model D to Model E). Social integration was strongly and positively associated with higher cognitive function (Model F), but did not account for any of the effects of neighborhood institutions (although social integration explained a marginal part of the positive effect of neighborhood age structure among those living in elderly neighborhoods between 6–10 years, Model D to Model F). Results from Model F also indicate that some of the social disparities in cognition are a function of fewer opportunities for social engagement among the less educated, homemakers and men. At this point these analyses have explained 33% of the variance in cognitive function in our sample by including a range of individual and neighborhood characteristics (R^2=.33, Model F). But significant variation in cognition remains between neighborhoods (ICC=.21, Model F) suggesting that other unmeasured factors at the neighborhood and/or individual level remain to be accounted for.

DISCUSSION

Using data from a large representative sample of older Chicago adults we tested the complex pathways in the relationship between neighborhood characteristics and cognitive function. Similar to other studies (16, 19) we found significant variation in cognitive function across neighborhoods at a level that is rarely seen in the literature on neighborhoods and health (31), suggesting that neighborhood characteristics may be a source of unexplored differences in cognitive function across adults living in different settings. We also replicated the findings that neighborhood socioeconomic disadvantage is related to cognition (16,18,19). However, we went beyond the current literature by examining the effects of neighborhood affluence on cognition in addition to disadvantage, and modeled the mediating effects of neighborhood resources and individual behaviors to explain the effects of neighborhood socioeconomic structure.

Whereas the negative effects of neighborhood disadvantage were effectively explained by common factors that both increase the risk of cognitive decline as well as select people into disadvantaged neighborhoods, neighborhood affluence had a net positive association with cognitive function that operated in part through a greater density of institutional resources such as community centers, schools, and libraries. However, the cognitive benefits of institutional resources were found only for white respondents, while a greater density of neighborhood institutions was negatively associated with cognitive function for African American and Hispanic respondents. This negative association suggests that neighborhood institutional resources hypothesized to promote cognitive function (16, 19) might have less benefit among racial and ethnic minority groups if language or cultural barriers prevent full access to opportunities offered within these institutions.

The positive relationship between institutional resources and cognition among white respondents was partly explained by physical activity, suggesting that resources such as community centers and senior centers may provide white older adults with the opportunity to exercise, which has been found to have positive consequences for cognitive function (vascular hypothesis) (32). By empirically examining this conceptual sequence, we show that neighborhood affluence (and the greater density of institutional resources in these areas) has the potential to act as a source of “cognitive reserve”, particularly for white adults who are aging in place in an urban setting.

Contrary to our expectations, a greater density of recreational centers and park area were not associated with cognitive function, suggesting the need examine alternate indicators of neighborhood resources that could promote cognitively beneficial physical activity. While social interaction was strongly and positively related to cognitive function, it did not account for any of the effects of institutions in our data. We also examined the effects of neighborhood age structure, speculating that cognitive function would be better when living in an area with a higher proportion of older adults, in part through increased opportunities for social interaction with peers as well as the exchange of information about resources and services (33, 34). As hypothesized, residence in an area with a higher proportion of older adults was positively associated with cognitive function for those with more stable exposures to these neighborhoods (residence over 5 years) but was negatively associated with cognition for very long term residents of these types of neighborhoods (more than 10 years). While a stable period or exposure to neighborhoods with a higher proportion of older adults may provide opportunities for more peer group interaction (33, 34) (although our measure of social interaction was only marginally able to detect any mediating effect), prolonged exposure to older adult neighborhoods may reflect a collective aging in place that is associated with structural decline (35), with adverse consequences for cognitively healthy behaviors.

Limitations

This study was limited to older adults living in the city of Chicago, and the findings may not be generalizable to other urban centers. Further studies in other settings are needed to investigate these relationships further. Measures of physical activity and social integration were based on self-report, which may have limited the strength of their association with cognitive function. Cross-sectional data also preclude an understanding of the direction of association between variables, and we are unable to rule out reciprocal causation. However, our capacity to examine the impact of the urban environment on cognitive function was considerably enhanced by using independent observational measures of the neighborhood characteristics that adults encounter in their day-to-day lives.

In summary, these findings emphasize the importance of considering urban design for the cognitive health of older adults who are aging in place. Although people with dementia may

be concentrated in institutions, the majority of older adults with dementia live in the community (36). Our results stress the importance of intelligent design of outdoor environments for individuals at risk for cognitive decline (37, 38).

WHAT THIS PAPER ADDS

What is Already Known

Existing research to date has speculated that living in highly educated and socioeconomically advantaged neighborhoods can promote cognitive function and/or buffer cognitive decline in part through their greater density of physical resources (recreational centers, gyms, parks, walking paths, healthy food stores) as well as social and institutional resources (libraries, bookstores, community centers, social clubs) that promote protective health behaviors (e.g. physical activity) and facilitate mental stimulation (e.g. social interaction and cognitive activities such as reading and/or playing games). However, to date these hypothetical pathways have not been empirically tested.

What this Study Adds

Using representative data from a cross-sectional survey of community dwelling older adults, this study examined the complex pathways in the relationship between neighborhood socioeconomic structure and cognitive function. Residence in an affluent neighborhood had a net positive effect on cognitive function after adjusting for individual risk factors. For white respondents, the effects of neighborhood affluence operated in part through a greater density of institutional resources (e.g. community centers) that promote cognitively beneficial activities such as physical activity. Stable residence in an elderly neighborhood was associated with higher cognitive function (potentially due to greater opportunities for social interaction with peers), but long term exposure to such neighborhoods was negatively related to cognition. Neighborhood resources have the potential to promote “cognitive reserve” for adults who are aging in place in an urban setting.

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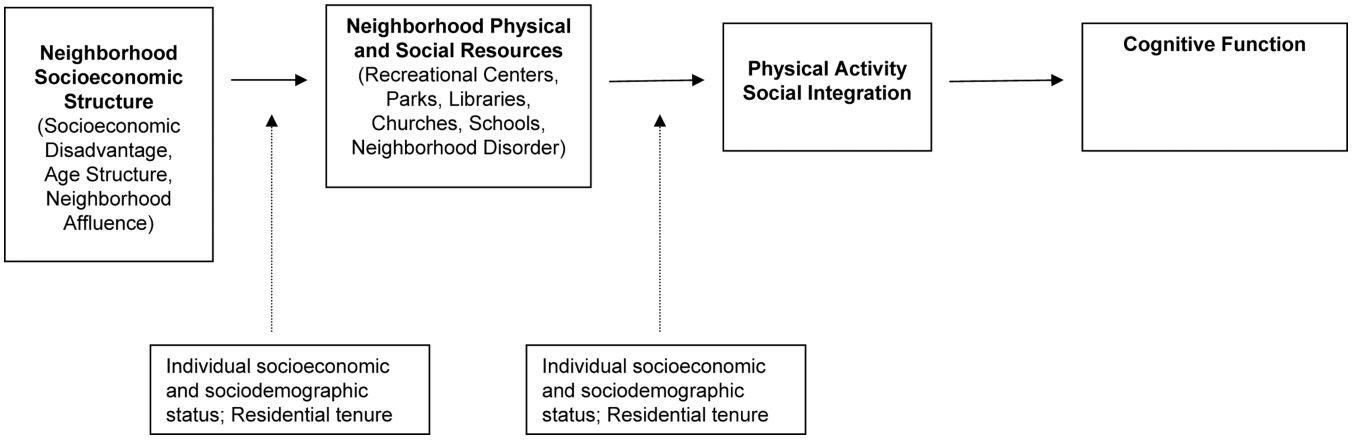

Figure 1.
Hypothesized Pathways in the Relationship between Neighborhood Socioeconomic Structure and Cognitive Function, Including Cross-Level Interactions (dotted lines)

Table 1

Descriptive Statistics for Study Sample (N=949): Chicago Community Adult Health Study (age 50+)

	Weighted Mean (SD) or Percent
Sociodemographic Characteristics	
Age 50–59	41.5
Age 60–69	28.9
Age 70+	29.6
Male	43.6
White	42.6
Black	37.1
Hispanic	17.7
Other Race/Ethnicity	2.6
Married	49.0
Separated/Divorced	21.4
Widowed	19.9
Never Married	9.7
Less than high school education	33.7
High school diploma	44.5
College degree or higher	21.8
Income less than $15,000	22.1
Income $15–40,000	24.4
Income greater than $40,000	31.0
Income missing	22.5
Employed	42.9
Unemployed	4.0
Retired	46.3
Homemaker	6.8
Residential tenure 5 years or less	25.0
Residential tenure 6 to 10 years	13.6
Residential tenure 10+ years	61.4
Health Status	
Cognitive function	13.3 (3.9)
Number of chronic health conditions	2.2 (1.8)
Physical Activity and Social Integration	
Social Integration	4.1 (1.2)
Civic Engagement	48.5
No Physical Activity	12.1
Some Physical Activity	64.5
Heavy Physical Activity	23.4
Neighborhood Census Indicators (Census Tract Level)	
Neighborhood Socioeconomic Disadvantage	22.8 (11.2)
Neighborhood Affluence	23.4 (11.8)

	Weighted Mean (SD) or Percent
Percent Older Adults	11.5 (5.6)
Neighborhood Resources (Census Tract Level)	
Percent of Blocks with Recreational Centers	4.4 (14.3)
Percent of Blocks with Institutional Resources	45.1 (36.3)
Park Area (square miles)	.02 (.04)
Neighborhood disorder index	−1.9 (1.6)

SD = standard deviation

Table 2

Effects of Neighborhood Characteristics, Controls and Mediators On Cognitive Function: Chicago Community Adult Health Study, Age 50+ (N=949)

	Unconditional Model	+ NB Census	+ Individual Controls	+ NB Resources	+ Physical Activity	+ Social Interaction
	Model A	**Model B**	**Model C**	**Model D**	**Model E**	**Model F**
Fixed Effects						
Intercept	13.21***	13.31***	18.15***	17.43***	16.85***	13.88***
NB Census Indicators[1]						
Socioeconomic Disadvantage		−.45**	.02	−.01	−.01	.04
Affluence		.91***	.28*	.15	.14	.17
% Older Adults		−.18	−.41**	−.53**	−.52**	−.52**
× Tenure 0–5yrs[g]			.10	.16	.15	.14
× Tenure 6–10yrs[g]			.92**	.97**	.96**	.94**
NB Resources [1]						
Recreational Centers				.11	.11	.09
Park Area (sq. miles)				.16	.17	.17
Institutional Resources[2]				1.81***	1.73***	1.73***
× Black[b]				−1.74*	−1.70*	−1.82**
× Hispanic[b]				−1.72	−1.67	−1.60
× Other Race/Ethnicity[b]				.79	.76	1.07
Neighborhood Disorder				−.23	−.22	−.27
Individual Factors						
Age 60–69[a]			−.41	−.49	−.48	−.48
Age 70+[a]			−1.47***	−1.50***	−1.44***	−1.37***
Male			−.63**	−.72**	−.71**	−.46*
Black[b]			−1.38***	−.65	−.63	−.37
Hispanic[b]			−1.52***	−.95	−.96	−.72
Other Race/Ethnicity[b]			−2.53***	−2.72*	−2.77*	−2.79*

	Unconditional Model	+ NB Census	+ Individual Controls	+ NB Resources	+ Physical Activity	+ Social Interaction
	Model A	**Model B**	**Model C**	**Model D**	**Model E**	**Model F**
<HS Education[c]			−2.77***	−2.69***	−2.70***	−2.21***
HS Education[c]			−1.18***	−1.13***	−1.15***	−.92**
Income <$15K[d]			−1.01**	−.85*	−.81*	−.68
Income $15–40K[d]			−.91**	−.76*	−.75*	−.71*
Income Missing[d]			−.74*	−.59	−.57	−.42
Separated/Divorced[e]			−.46	−.55	−.55	−.61*
Widowed[e]			−1.01**	−1.10***	−1.08***	−1.15***
Never Married[e]			−.96*	−1.25***	−1.22**	−1.16**
Unemployed[f]			−.24	−.28	−.27	−.21
Retired[f]			−.74*	−.72*	−.69*	−.62*
Homemaker[f]			−1.22**	−1.24**	−1.20**	−1.06*
Health Conditions			−.14*	−.16**	−.14*	−.13*
Residential Tenure 0–5yrs[g]			.12	.15	.14	.23
Residential Tenure 6–10yrs[g]			.02	.19	.22	.27
Individual Mediators						
Some Physical Activity[h]					.55	.38
Heavy Physical Activity[h]					.71*	.49
Social Integration						.53***
Civic Engagement						.57**
Variance Components						
Intercept (Tract Level)	4.25***	3.06***	1.91***	1.90***	1.87***	1.96***
ICC	.29	.23	.20	.19	.19	.21
Goodness-of-Fit Statistics						
Pseudo R^2		.08	.30	31	31	33

*p<.05

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[**] p<.01

[***] p<.001

[1] grand mean centered

[2] e.g. libraries, churches, schools, community centers

[3] standardized ICC=intraclass correlation coefficient

[a] Reference group is Age 50–59

[b] Reference group is white

[c] Reference group is college degree or higher (16+ years of education)

[d] Reference group is income $40,000 or higher

[e] Reference group is married

[f] Reference group is employed

[g] Reference group is Residential tenure 10+ Years

[h] Reference group is no physical activity